

AMENDMENTS TO THE CLAIMS

Claim 1 (Currently Amended) An optimizing method that optimizes, using a computer, a component mounting order in which a mounter, equipped with a mounting head, picks up, at maximum, L components, L being no less than 2, from an array of component feeders that hold components, and mounts the components on a board,

wherein the mounting head has, at maximum, L pickup nozzles attached thereto for picking up the components, ~~L being no less than 2~~, and

wherein a plurality of components, of which the mounting order is to be optimized,-
~~include plural~~ includes a plurality of types of components ~~which are to be~~ picked up using no less than 2 pickup nozzles of different types, and

the optimizing method comprising:

~~a nozzle set determination step of determining a nozzle set, from a plurality of pickup nozzles, for mounting all the plurality of components with~~ using a smallest possible number of tasks-task number, where a nozzle set is a combination of pickup nozzles in which (i) only the types of the pickup nozzles and a number of the pickup nozzles to be attached to the mounting head are previously set and (ii) a correspondence between the types of the pickup nozzles and mounting positions of the pickup nozzles is not previously set, and where a task is a group of components to be mounted by one iteration of the a repeated series of processes where the mounting head picks up, transports, and mounts the components; and

~~a mounting order determination step of determining the array an order of the array of component feeders and the a component mounting order, while maintaining the determined nozzle set.~~

Claim 2 (Currently Amended) The optimizing method according to Claim 1,

wherein the pickup nozzles attached to the mounting head are interchangeable, and

~~wherein the determination of the nozzle set determines determination step, a nozzle set-~~
~~is determined, said nozzle set reducing that reduces~~ a mounting time in view of ~~the (i) a number~~ of times of interchanging the pickup nozzles for mounting the components and (ii) a total number

of tasks.

Claim 3 (Currently Amended) The optimizing method according to Claim 2, wherein, in the determination of the nozzle set-determination step, i) at least one kind of nozzle set is specified, ~~said the specified~~ the specified nozzle set corresponding to the number of times of interchanging the pickup nozzles, ii) ~~the task number~~ a number of tasks required for mounting the plurality of components is calculated using the specified nozzle set, iii) a combination of the number of times of interchanging the pickup nozzles and the calculated task number of tasks required for mounting the plurality of components is estimated, and iv) the nozzle set is determined as a result of the estimation.

Claim 4 (Currently Amended) The optimizing method according to Claim 3, wherein the determination of the nozzle set-determination step ~~includes:~~ further comprises:

further calculating a the number of tasks-task required for mounting the plurality of components by-number calculation step ~~of repeating the processing of calculating of the task number of tasks required~~ for mounting the plurality of components using “n” kinds of nozzle sets, “n” being no less than 1, while incrementing the “n” by 1; and

a nozzle set number specification step ~~of calculating an evaluated value S_i corresponding to the mounting time, according to a predetermined evaluation function, specifying a nozzle set of the “n” kinds-kind of nozzle sets-set corresponding to a combination of pickup nozzles in which the evaluated value S is the smallest, and-determining setting the specified-“n” kind of nozzle set as the determined nozzle set.~~

Claim 5 (Currently Amended) The optimizing method according to Claim 4, wherein the further calculating of task the number of tasks ~~further comprises: calculation step includes the following steps:~~

calculating a-task number of tasks, for a case in which the plurality of components are mounted on a board, for using the mounting head to pick up as many of the-on which L

components are picked up as many as possible, as a minimal task number; and

judging for each task, of the number of tasks calculated by the calculating of the number of tasks for using the mounting head, number whether or not it is possible to mount all the plurality of components by incrementing the calculated ~~minimum~~ minimal task number by 1, and obtaining a minimum task number, when the judging for each task judges that it is judged as possible to mount the plurality of components, as the task number of tasks required for mounting all the plurality of components using “n” kinds of nozzle sets.

Claim 6 (Currently Amended) The optimizing method according to Claim 5, wherein, in the further calculating of the number of tasks, ~~task number calculation step, a task~~ the number of tasks required for mounting the plurality of components by a nozzle set is incremented, ~~said task number of the nozzle set, for which the number of tasks is incremented being from, out of a~~ plurality of nozzle sets determined immediately before the further calculating of the number of tasks, and the incrementing of the number of tasks required for mounting the plurality of components resulting in having fewer “empty head” which is a state in which a mounting head is empty when performing a task for components fewer than the number L.

Claim 7 (Currently Amended) The optimizing method according to Claim 5, wherein the further calculating of the ~~task number of tasks calculation step further includes~~ comprises calculating the ~~task number of tasks~~ required for mounting all of the plurality of components by decrementing the calculated minimum task number by 1.

Claim 8 (Currently Amended) The optimizing method according to Claim 7, wherein, in the further calculating of the number of tasks ~~task number calculation step, the task number of~~ tasks required for mounting the plurality of components by a nozzle set is decremented, ~~said task number of the nozzle set, for which the number of tasks is decremented being from out of plural~~ a plurality of nozzle sets determined immediately before the further calculating of the number of tasks, and the decrementing of the number of tasks required for mounting the plurality of

components resulting in having more “empty head” which is a state in which a mounting head is empty when performing a task for components fewer than the number L.

Claim 9 (Currently Amended) The optimizing method according to Claim 4,

wherein a the number of usable pickup nozzles is restricted depending on the type of pickup nozzles, and

wherein, in the determination of the nozzle set determination step, when the “n” kinds of nozzle sets are respectively determined, a combination of a pickup nozzle and the a number of components to be mounted using ~~said~~ the pickup nozzle is specified to be for the number L or fewer within the restricted number of usable pickup nozzles range.

Claim 10 (Currently Amended) The optimizing method according to Claim 4, wherein, in

the further calculating of the number of tasks, task number calculation step, the possible combinations of pickup nozzles, for the each task numbers calculated using the respective “n” kinds of nozzle sets, are extracted, whether or not it is possible to mount all the plurality of components is sequentially judged for all of the extracted combinations of pickup nozzles, and a minimum task number, for which the sequentially judging judges that it is judged as possible to mount the plurality of components, is obtained as the task number of tasks required for mounting the plurality of components using “n” kinds of nozzle sets.

Claim 11 (Currently Amended) The optimizing method according to Claim 10, wherein, in

the further calculating of the number of tasks, task number calculation step, the possible combinations of pickup nozzles are extracted from a restricted range of pickup nozzles specified by minimum and maximum task numbers, ~~said~~ the minimum task number is being a task number of tasks required for mounting as many of the plurality of components on a board as many as possible[[,]] using a mounting head by which L components are picked up, and ~~said~~ the maximum task number is the being a number of components having the largest number out of the components classified based on the type of pickup nozzles.

Claim 12 (Currently Amended) The optimizing method according to ~~Claim~~ Claim 4, wherein the further calculating of the number tasks further comprises: task number calculation ~~step includes:~~

a first calculation step of: calculating a ~~task number~~ of tasks, for a case in which the plurality of components are mounted on a board, for using a mounting head to pick up as many of the on which L components are picked up as many as possible, as a minimal task number; judging whether or not it is possible to mount ~~all the~~ plurality of components for each task of the number of tasks calculated by the first calculation step number by incrementing the calculated-~~minimum~~ minimal task number by 1; and obtaining a minimum task number, when the judging of each task ~~judges~~ judged as that it is possible as to mount the plurality of components, as the task number of tasks required for mounting the plurality of components using “n” kinds of nozzle sets;

a second calculation step of: extracting ~~the possible combinations of pickup nozzles, for the each task numbers~~ calculated by using the respective “n” kinds of nozzle sets; sequentially judging ~~sequentially~~ whether or not it is possible to mount ~~all the~~ plurality of components for all of the extracted combinations of pickup nozzles; and obtaining a minimum task number, for which the sequentially judging judges that it is judged as possible to mount the plurality of components, as the task number of tasks required for mounting the plurality of components- ~~calculated using the “n” kinds of nozzle sets; and~~

~~a selection step of executing selectively either the first calculation step or the second calculation step.~~

Claim 13 (Currently Amended) The optimizing method according to Claim 2, wherein, in the determination of the nozzle set ~~determination step~~, a nozzle set which obtains the a smallest evaluated value S is determined as the nozzle set that reduces ~~a the~~ mounting time, ~~said the~~ smallest evaluated value S is calculated using $S = X + h \cdot N$, where N indicates the number of times of interchanging the pickup nozzles, X indicates the total ~~task number~~ of tasks, and h indicates a coefficient for converting the time taken ~~by interchanging~~ to interchange the pickup

nozzles into a task number.

Claim 14 (Currently Amended) The optimizing method according to Claim 2, further comprising ~~a nozzle pattern determination step of~~ determining a nozzle pattern in which a type of pickup nozzle is assigned to each of a plurality of heads constituting ~~composing~~ the mounting head for all of the tasks required for mounting the plurality of components, while maintaining the nozzle set determined in the determination of the nozzle set ~~determination step~~.

Claim 15 (Currently Amended) The optimizing method according to Claim 2, wherein the mounter includes a nozzle station at which the pickup nozzles are arranged, and
wherein the optimizing method further comprises ~~a nozzle station arrangement determination step of~~ determining a combination of a type of pickup nozzle ~~nozzles~~ to be arranged at the nozzle station and a place for the arrangement based on the nozzle set determined in the determination of the nozzle set ~~determination step~~.

Claim 16 (Currently Amended) The optimizing method according to Claim 2, wherein, in the determination of the mounting order ~~determination step~~, the components are classified into as ~~small components and or~~ general components based on heights of the components, the order of the array order of the component feeders and the component mounting order for the small components are determined so that a number of components to be picked up per task by the mounting head increases, while the order of the array order of component feeders and the component mounting order for the general components are determined based on ~~in a search of~~ a mounting order which reduces the mounting time while switching the an order of mounting components.

Claim 17 (Currently Amended) The optimizing method according to Claim 1, wherein ~~in the determination of the nozzle set determination step~~, determines the nozzle set ~~and the task~~

number are determined, said nozzle set for mounting all the plurality of components with the smallest possible number of tasks ~~task number~~, without interchanging the pickup nozzles attached to the mounting head.

Claim 18 (Currently Amended) The optimizing method according to Claim 17, wherein the determination of the nozzle set further comprises: ~~determination step includes:~~

~~an initial nozzle set calculation step of~~ for each type of pickup nozzle, initially calculating the a number of pickup nozzles for each type as of an initial nozzle set based on the a number of components to be picked up, respectively, by the different types of pickup nozzles;

~~an initial task number calculation step of~~ initially calculating a total ~~task number of tasks~~ for mounting all the plurality of components based on the a number of components corresponding to the calculated number of pickup nozzles of the initial nozzle set;

~~a task number calculation step of~~ calculating a total ~~task number of tasks~~ for mounting the plurality of components when the number of pickup nozzles of the initial nozzle set is incremented or decremented by 1 for each type of pickup nozzle of the initial nozzle set; and

~~a judgment step of~~ judging whether or not the total ~~task number of tasks~~ calculated in the ~~task number calculation step~~ calculating of the total number of tasks is smaller than the total ~~task number of tasks~~ calculated in the initially calculating of the total number of tasks ~~initial task number calculation step~~, and when the former is smaller than the latter, the judgment is made as to ~~on~~ whether or not the decremented or incremented total ~~task number of tasks~~ becomes smaller after the incremented or decremented nozzle set has been updated as a latest nozzle set, and when the former is not smaller than the latter, ~~the a previous nozzle set and the total task number of tasks for said of the previous nozzle set are determined as the initial nozzle set and the number of tasks task, respectively number.~~

Claim 19 (Currently Amended) The optimizing method according to Claim 18, wherein the respective plurality of components belong to one of a plurality of component groups classified based on heights of the components, and

~~wherein the task calculating of the total number of tasks further comprises: calculation-~~
~~step includes:~~

~~_____ a component group task number calculation step of calculating a respective task~~
~~number of tasks required for mounting all the components belonging to of each of said~~
~~component group-groups; and~~

~~_____ a total task number calculation step of calculating a total group task number of~~
~~tasks by totaling each of the respective numbers of tasks-task numbers calculated by the~~
~~calculating of the respective number of tasks in units of component groups.~~

Claim 20 (Currently Amended) The optimizing method according to Claim 19, wherein, in
the ~~calculating of the respective number of tasks~~ ~~component group task number calculation step~~,
when a component group includes ~~a plurality of plural~~ types of components to be picked up using
a plurality of pickup nozzles, a maximum task number, out of task numbers corresponding,
respectively, to the plurality of pickup nozzles, is obtained as a ~~task number of tasks~~ of the
component group[[],].

Claim 21 (Currently Amended) The optimizing method according to Claim 1 further
comprising:

~~a component group allocation step of allocating the plurality of components to two or~~
~~more mounters in units of component groups so that task numbers~~ ~~a number of tasks of each of at~~
the two or more mounters is averaged, when a task is a group of components to be mounted by
one iteration of the repeated series of processes where the mounting head picks up, transports,
and mounts ~~the~~ components; and

~~a component moving step of modifying the allocation of the allocating of the plurality of~~
~~components~~ by moving a part of ~~the~~ components allocated to a mounter with a larger ~~task~~
~~number of tasks~~ to a mounter with a smaller ~~task number of tasks~~ so that all ~~of~~ the allocated
components are mounted without interchanging the pickup nozzles attached to the mounting
head and the ~~number of tasks of each of task numbers for~~ the two or more mounters is averaged.

Claim 22 (Currently Amended) The optimizing method according to Claim 21, wherein, in the allocating of the plurality of components ~~component group allocation step~~, a ~~process~~ processing of modifying the allocation by sequentially moving ~~sequentially~~ the component groups allocated to the mounter with a the larger task number of tasks to another mounter ~~that is connected~~ adjacently connected to said the mounter with the larger number of tasks after having allocated all of the component groups to the two or more mounters so that the component groups of low components are allocated to a mounter positioned upstream in a production line, is repeated until a size relation between the ~~task numbers~~ number of tasks of for the two mounters reverses, and when the size relation is reversed, the previous state in which the component groups are allocated is determined as a final state.

Claim 23 (Currently Amended) The optimizing method according to Claim 21, wherein, in the modifying of the allocation ~~component moving step~~, the components to be moved are determined based on a difference between the ~~task numbers~~ number of tasks of at the respective two or more mounters for mounting the components allocated in the allocating of the plurality of components ~~component group allocation step~~, and the determined components are moved.

Claim 24 (Currently Amended) The optimizing method according to Claim 23, wherein, in the modifying of the allocation ~~component moving step~~, when a component ~~such that requires~~ requiring a new pickup nozzle is moved from ~~the~~ a second mounter to ~~the~~ a first mounter, a space for the new pickup nozzle is retained by determining a pickup nozzle, with which a ~~task number of tasks~~ task number becomes the smallest, ~~out of from~~ from a plurality of pickup nozzles assigned to ~~a~~ the first mounter, ~~said task~~ the number of tasks being incremented by decrementing ~~the~~ a number of pickup nozzles by 1.

Claim 25 (Currently Amended) The optimizing method according to Claim 1 further comprising:

~~a nozzle allocation step of~~ allocating pickup nozzles by determining types and numbers of

pickup nozzles for respective two or more mounters according to types and numbers of components allocated to the respective two or more mounters;

~~a task number calculation step of calculating a number of tasks required for mounting components allocated to the mounters by modifying the number of pickup nozzles determined in the allocating of the pickup nozzles~~ nozzle allocation step based on a restriction on a nozzle resource number that is the a number of usable pickup nozzles, and of calculating a task number of tasks for at each mounter ~~such that the types and numbers of pickup nozzles for mounting all of the components allocated to each mounter can be mounted without interchanging the pickup nozzles~~ based on the number of pickup nozzles after the modification and the corresponding number of components; and

~~a nozzle number adjustment step of incrementing or decrementing the number of pickup nozzles allocated to each mounter so that a difference between the number of tasks required by each mounter~~ mounters in task numbers calculated in the calculating of the number of tasks required for mounting components ~~task number calculation step is reduced.~~

Claim 26 (Currently Amended) The optimizing method according to Claim 25, wherein, in the incrementing or decrementing of the number of pickup nozzles ~~nozzle number adjustment step, a difference between in task numbers~~ a number of tasks between the of a first and a second mounter ~~mounters~~ is reduced by incrementing the number of pickup nozzles allocated to the first mounter with having a larger task number of tasks by the number “n” and decrementing the pickup nozzles allocated to the second mounter with having a smaller task number of tasks by the number “n”, when the pickup nozzles of the same type are allocated to the first and second mounters.

Claim 27 (Currently Amended) An optimizing apparatus that optimizes, using a computer, a component mounting order in which a mounter₁ equipped with a mounting head₁ picks up, at maximum, L components, L being no less than 2, from an array of component feeders that hold components, and mounts the components on a board,

wherein the mounting head has, at maximum, L pickup nozzles attached thereto for picking up the components, ~~L being no less than 2~~, and

wherein a plurality of components, of which the mounting order is to be optimized,
includes a plurality of~~include plural~~ types of components which are to be picked up using no less than 2 pickup nozzles of different types, and

the optimizing apparatus comprising:

_____ a nozzle set determination unit operable to determine a nozzle set, from a plurality of pickup nozzles, for mounting ~~all the plurality of components with~~ using a smallest possible number of tasks~~task number~~, where a nozzle set is a combination of pickup nozzles in which (i) only the types of the pickup nozzles and a number of the pickup nozzles to be attached to the mounting head are previously set and (ii) a correspondence between the types of the pickup nozzles and mounting positions of the pickup nozzles is not previously set, and where a task is a group of components to be mounted by one iteration of the a repeated series of processes where the mounting head picks up, transports, and mounts the components; and

_____ a mounting order determination unit operable to determine an order of the array-
order of component feeders and the a component mounting order, while maintaining the determined nozzle set.

Claim 28 (Currently Amended) A ~~mouter-equipped with~~ comprising a mounting head which picks up, at maximum, L components, L being no less than 2, from an array of component feeders that hold components, and mounts the components on a board,

wherein the components are mounted in a mounting~~an order of mounting components,~~
optimized by the optimizing method according to Claim 1.

Claim 29 (Currently Amended) A computer-readable storage medium having a program stored thereon, the program ~~for an optimizing apparatus that optimizes, using a computer,~~ a component mounting order in which a mouter, equipped with a mounting head, picks up, at maximum, L components, L being no less than 2, from an array of component feeders that hold

components, and mounts the components on a board, the program causing ~~the~~ a computer to execute ~~the steps included in~~ the optimizing method according to Claim 1.

Claim 30 (Cancelled)